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TRANSPORT SUSTAINABILITY IN THE UNITED STATES: LEADING FROM BELOW

Catherine Ross,* Chisun Yoo and Bruce Stiftel*****

INTRODUCTION

Climate change, global connectivity, uneven development, financial constraints, and resource depletion have all contributed to an energized and renewed effort in pursuit of a sustainable future. The United Nations has catalyzed this effort significantly through the development of the 2030 Agenda for Sustainable Development. The 1960s were declared “The Development Decade” by the United Nations, and it has led several initiatives since, culminating most recently in the Sustainable Development Goals (SDGs), which replaced the Millennium Development Goals (Madeley, 2015). The new agenda includes 17 SDGs and 169 targets. It is structured to provide progress over the next 15 years to achieve many ambitious outcomes, including the eradication of poverty and the attainment of more sustainable development. In 2017, the United Nations General Assembly adopted a global indicator framework to monitor the 2030 agenda for sustainable development, generating a total of two hundred thirty-two global indicators.

Transportation is a crucial component of the call for a global collaborative effort in support of the SDGs. These objectives are embraced by citizens, NGOs, and governments throughout the world. Europe has taken up this charge and regularly informs and reports on the progress of goal attainment, including sustainable transportation. Approximately 23% of Europe’s greenhouse gas emissions are attributable to transport.¹ “More recently, transportation agencies in the U.S. have begun to develop processes and tools to gather and analyze information on system interactions in order to make more effective investment decisions. Other countries have researched transportation and sustainability for several years, and as a result, international experiences can provide several valuable lessons” (Amekudzi et al., 2011). The United Nations global partnership links sustainable development, economics, social and environmental factors to goals and

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¹ European Initiative for the Future of Urban Mobility. Retrieved from <https://www.eiturbanmobility.eu>

targets. These global concerns are far-reaching and include the need to develop innovative approaches to the sustainable construction, operation, design, and social impact of transportation systems (CH2M HILL & Good Company, 2009). If the most impoverished areas in the world follow the development pattern of western countries, sustainability will suffer setbacks (Shay & Khattak, 2010). A multimodal, diverse, sustainable transportation system is critical if we are to achieve sustainable cities and regions.

In this article, we focus on developing a better understanding of the recent trends and progress toward sustainable transportation in the United States. The transport system in the United States is resource-intensive, and with increasing population will be even more resource depleting with increasing negative impacts on quality of life (Plevak, 2012). The automobile dominates transportation in America, and many would agree the movement toward sustainable transport here is lagging while the global focus is sharpening. Developing a more sustainable transport system faces significant challenges, including congestion, air pollution, global warming, reliance on petroleum, vehicular accidents, and the negative impacts on the environment and overall quality of life.

Approximately 1.24 million people die every year from vehicular crashes, with the majority of these occurring in low and middle-income countries.² The reliance on nonrenewable fossil fuels is a significant contributor to climate change, and air quality has substantial impacts on health. Transportation is a major driver of climate change and has facilitated sprawling towns, cities, and regions in the United States. Currently, land use planning and transportation policy pose formidable challenges to the creation of a sustainable mobility system that meet long-term transport needs (Black, 1996). The requirement that we do not consume natural resources that put future generations at risk is a basic tenet of sustainability.

Transportation affects non-transport sectors, including housing, the environment, employment, city structure, land planning, etc. Transportation planning requires meaningful, bottom-up solutions (Badger, 2013). Perhaps, nothing shapes the operation and character of regions and cities in a community as much as transportation. Transport is a primary driver in the social and economic activities and travel of U.S. citizens in their everyday life. Consequently, it is not surprising that transportation sustainability, as a result of the number of sectors and activities that it connects, also holds the promise of a more sustainable future.

² World Health Organization. *Global Health Observatory Data –Road Traffic Deaths*. Retrieved from www.who.int/gho/road_safety/mortality

We first examine different concepts and approaches to transport sustainability and the role of indicators through a review of the literature. In Part II, we view sustainability in the United States as evaluated in the 2019 U.S. Cities Sustainable Development Report. In Part III, we examine transport sustainability trends and develop indicators for the ten largest Metropolitan Statistical Areas (MSAs) in the United States. We then relate these results to relevant SDG indicators. Part IV is a review of findings and includes guidance and policy recommendations critical to the development of sustainable transport now and in the future.

I. MEASURING TRANSPORT SUSTAINABILITY

Review of UN sustainability agendas

The role of transport in sustainable development was first recognized at the 1992 United Nations Earth Summit and in *Agenda 21*.³ The global attention to transport has continued until now. The latest global agenda, the *2030 Agenda for Sustainable Development*,⁴ focuses explicitly on transportation sustainability.

Before the *2030 Agenda*, The Millennium Development Goals (MDGs) were adopted by the U.N. in the Millennium Declaration of 2000. Eight goals with 21 targets comprised the blueprint for reducing extreme poverty and enhancing overall human well-being. However, the notion of sustainability was only addressed in Goal 7, “Ensure environmental sustainability,” while the other goals address either basic needs (Goal 1, 2, 4, 5, and 6), equality (Goal 3), and development partnerships (Goal 8).

The SDGs, in contrast, cover a wider range of themes regarding sustainability and human well-being (Table 1). The SDGs, key to the *2030 Agenda for Sustainable Development* (2030 Agenda), were adopted by the United Nations Member States⁵ in 2015. The *2030 Agenda* is a plan of action for people, planet, and prosperity, with 17 SDGs and 169 targets.⁶ Although some goals overlap, unlike the MDGs, the SDGs include three goals that are related to sustainable transport. They are goal numbers 3, 9, and 11. Those goals are directly related to

³ United Nations, Conference on Environment and Development. *Agenda 21*. Rio de Janeiro: 1992. https://www.un.org/esa/dsd/agenda21/res_agenda21_00.shtml

⁴ United Nations. *Transforming Our World: The 2030 Agenda for Sustainable Development*. A/RES/70/1. New York: 2015.

⁵ UN Sustainable Development Goals Knowledge Platform. *Sustainable Development Goals*. Retrieved from <https://sustainabledevelopment.un.org/?menu=1300>

⁶ United Nations. *Transforming our world: The 2030 agenda for sustainable development* (2015)

sustainable transport.⁷ Table 2 below lists the key targets and indicators relevant to transportation.

⁷ UN Sustainable Development Goals Knowledge Platform. *Sustainable transport*. Retrieved from <https://sustainabledevelopment.un.org/topics/sustainabletransport>

Table 1. Comparison of Millennium Development Goals and UN Sustainable Development Goals

Domain	MDGs (2000)	SDGs (2015)
Basic needs & Health	<ul style="list-style-type: none"> · Goal 1: Eradicate extreme poverty and hunger · Goal 2: Achieve universal primary education · Goal 4: Reduce child mortality · Goal 5: Improve maternal health · Goal 6: Combat HIV/AIDS, malaria and other diseases 	<ul style="list-style-type: none"> · Goal 1: End poverty in all its forms everywhere · Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture · Goal 3: Ensure healthy lives and promote well-being for all at all ages · Goal 6: Ensure availability and sustainable management of water and sanitation for all
Equality	<ul style="list-style-type: none"> · Goal 3: Promote gender equality and empower women 	<ul style="list-style-type: none"> · Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all · Goal 5: Achieve gender equality and empower all women and girls · Goal 10: Reduce inequality within and among countries
Environment	<ul style="list-style-type: none"> · Goal 7: Ensure environmental sustainability 	<ul style="list-style-type: none"> · Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all · Goal 12: Ensure sustainable consumption and production patterns · Goal 14: Conserve and sustainably use the oceans, seas, and marine resources for sustainable development · Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss · Goal 13: Take urgent action to combat climate change and its impacts
Development	<ul style="list-style-type: none"> · Goal 8: Develop a global partnership for development 	<ul style="list-style-type: none"> · Goal 17: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development
	New in SDGs	<ul style="list-style-type: none"> · Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels · Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all · Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation · Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable

Table 2. Relevant SDG indicators to transportation and cities

Goal 3. Ensure healthy lives and promote well-being for all at all ages	
Targets	Indicators
3.4 By 2030, reduce by one-third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being	3.4.1 Mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease
3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents	3.6.1 Death rate due to road traffic injuries
3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air , water, and soil pollution and contamination	3.9.1 Mortality rate attributed to household and ambient air pollution
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	
Targets	Indicators
9.1 Develop quality, reliable, sustainable and resilient infrastructure , including regional and transborder infrastructure , to support economic development and human well-being, with a focus on affordable and equitable access for all	9.1.2 Passenger and freight volumes, by mode of transport
9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities	9.4.1 CO2 emission per unit of value-added
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable	
Targets	Indicators
11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety , notably by expanding public transport , with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons	11.2.1 Proportion of population that has convenient access to public transport , by sex, age, and persons with disabilities
11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management	11.6.2 Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)
Goal 13. Take urgent action to combat climate change and its impacts	
Targets	Indicators
13.2 Integrate climate change measures into national policies, strategies, and planning	13.2.1 Number of countries that have communicated the establishment or operationalization of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production

Source: United Nations (2015) "Transforming our World: The 2030 Agenda for Sustainable Development"

Transport sustainability practices and indicators

According to the United States Environmental Protection Agency (USEPA), approximately 20% of particulate matter and more than 50% of nitrogen oxide are attributable to transportation. These emissions are more concentrated in communities near major interstates, arterials and other roadways (Karner et al., 2010; Ross et al., 2014). In August 2014, an advisory group on sustainable transport was formed by the Secretary-General of the United Nations. In his charge to the group, the Secretary-General asserted [the Group was structured to represent] “all modes of transport including road, rail, aviation, marine, ferry, and urban public transport providers. Sustainable transport achieves better integration of the economy while respecting the environment, improving social equity, health, the resilience of cities, urban-rural linkages, and productivity of rural areas.”⁸ This definition gave a broader concept of transport sustainability than was generally accepted. As one of its top 10 recommendations, the advisory group endorsed the development of evaluation frameworks for sustainable transportation in addition to the development of accurate data and the conduct of statistical analysis.⁹

The importance of sustainability has increased consistently over the last 40 to 45 years. However, the focus on transportation technology started earlier (Sultana et al., 2017) with an effort to improve the operation of the transportation system, improve accessibility, integrate more technology-driven improvements, and reduce the need for travel. Huang et al. (2017) describe sustainable transportation technology as solutions that, “include policies regarding innovation, infrastructure investment, energy efficiency, alternative fuels, pollution control, and intelligent transportation systems.” The authors further reference the need to consider the kinds of decisions that affect the built environment and the financial decisions that guide project selection and infrastructure investment. For example, these might include consideration of increased transit accessibility: integration of different modes, parking management systems; sustainable energy sources; and required adjustments for Transportation as a Service (TaaS) or Mobility as a Service (MaaS) et.al. Shared mobility presents the opportunity to examine past and current service delivery models, transportation finance, environmental impacts, transport design and operations, and to replace them with new technologies, business models, financing, energy sources, and innovative modes. This includes automated transportation systems that operate without a driver. There is an expectation that they will increase safety, reduce emissions, improve transport

⁸ UN Sustainable Development Goals Knowledge Platform. *Sustainable transport*. Retrieved from <https://sustainabledevelopment.un.org/topics/sustainabletransport>

⁹ *Id.*

system operations and make a substantial contribution to both the built environment and climate change.

Countries around the world have developed a wide variety of sustainability indicators related to transport. This includes transportation metrics at the city, urban, regional, and national levels (Buzási & Csete, 2015). In their system to measure transport sustainability, Shiau and others developed twenty-one indicators working in concert with government officials from Taipei City and New Taipei City to evaluate sustainable transportation policies (Shiau et al., 2013). Taipei operates under the guidance of the European Council of Ministers of Transport. It requires sustainable transport systems to provide basic access that is affordable, and reduces emissions and wastes (Banister, 2011). Their analysis demonstrated that expanding rapid transit improved transport system sustainability the most. Their indicatory allowed city officials to track and measure the improvement in sustainability related to various policy options.

The Federal Highway Administration (FHWA) of the United States Department of Transportation (USDOT) developed the INVEST (Infrastructure Volunteer Evaluation Sustainability Tool) as one framework to analyze urban transportation sustainability in the United States. In their work Ramani et al. (2018) reviewed INVEST. It is a web-based transportation self-assessment sustainability rating system. The tool includes best practices over the lifecycle of a transportation project or service. It assists transportation agencies in evaluating and improving the sustainability of their projects and programs, and the evaluation criteria employed in INVEST represents a broad definition of urban sustainability.

The INVEST framework includes system planning for states, regions, project development and operations, and maintenance. Each of the four modules is independent, and the Project Development module (PD) includes scorecards that allow sustainability assessment for projects throughout the state. The criteria used in INVEST include travel demand management, public health affordability, pedestrian and bicycle facilities, construction waste management, and others. The evaluation criteria employed in INVEST allow Departments of Transportation (DOTs), Metropolitan Planning Organizations (MPOs), cities and local transportation planning entities to evaluate trade-offs of benefits.¹⁰ However, INVEST falls short as a result of the lack of an all-inclusive sustainable transportation policy. While the U.S. does not have a national sustainable transportation policy, individual states and metropolitan areas have begun to develop their strategies to assess the sustainability of their investment decisions and

¹⁰ Federal Highway Administration. *Benefits of INVEST*. Retrieved from <https://www.sustainablehighways.org/1590/benefits.html>

operations (Amekudzi et al., 2011). Amekudzi et al. (2011) reviewed the approach and analytics employed by other countries to incorporate sustainability into transportation planning. For example, New Zealand's asserts, "Sustainable transport is about finding ways to move people, goods, and information in ways that reduce its impact on the environment, economy, and society." Sustainability is then operationalized by established objectives and measurable targets. The authors extend their assessment to include an examination of the inclusion of sustainability in the mission statement of state DOTs. Lastly, they examine case studies and programs throughout the country that have a sustainability element.

II. SUSTAINABILITY IN U.S. CITIES

The United States has been a reluctant participant in global data compilations on SDG performance, standing out as the only G20 or OECD nation not to have prepared or agreed to prepare a Voluntary National Report on SDG attainment. Nonetheless, many U.S. states, cities, corporations, and NGOs have stepped forward in myriad ways to advance the SDGs. As of 2019, the USA ranks 35th of 162 countries on the *SDG Index* widely disseminated by the U.N. Sustainable Development Solutions Network (SDSN)¹¹.

In preparation for the United Nations 2019 High-level Political Forum on Sustainable Development, U.N. Secretary-General António Guterres framed the global context:

*Despite considerable efforts these past four years, we are not on track to achieve the Sustainable Development Goals by 2030. We must dramatically step up the pace of implementation as we enter a decade for people and the planet.*¹²

The 2019 preparatory report chronicles the challenges facing cities and regions if the SDGs are to be attained, including the following: reducing greenhouse gas emissions, use of raw materials, impacts on biodiversity, vulnerability to hazards, inequality, enhancing planning and coordination, provision of basic services, mobility, and accessibility.¹³ The report goes on to identify co-benefits and trade-offs among the SDGs, finding that SDG11: Sustainable Cities and Communities is heavily interconnected with SDGs 6: Clean Water and Sanitation,

¹¹ Lynch, A., LoPresti, A., Fox, C. (2019): The 2019 US Cities Sustainable Development Report. New York, NY: Sustainable Development Solutions Network (SDSN).

¹² António Guterres, Forward. P. xi in Independent Group of Scientists appointed by the Secretary-General. *Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development*. New York, NY: United Nations.

¹³ Independent Group of Scientists. *Global Sustainable Development Report 2019*. P. xxviii.

7:Affordable and Clean Energy, 9:Industry, Innovation and Infrastructure, 12:Responsible Consumption and Production, 13:Climate Action, 14:Life Below Water, 15:Life on Land, and 17:Partnerships. Among other things, the report finds that globally, we are within ten percent of achieving key indicators of SDGs 6, 7, 9, and 11. However there are negative long-term trends that impede the attainment of SDGs 12, 13, 14, and 15.¹⁴ The United States is identified as scoring high on the achievement of many basic human needs but is among the worst performers on transgressing biophysical boundaries.¹⁵ This places the country in a similar position as many high-income countries.¹⁶

To better understand the United State's position internationally, it is important to consider factors such as the following: policy frameworks and commitments, efforts to mobilize the machinery of government, budgeting practices, national monitoring, stakeholder engagement mechanisms, and the content of policy strategies. The Sustainable Development Solutions Network compares the U.S. to 41 other countries. This included the European Union and all G20 countries, most other OECD countries, and all countries with a population of over 100 million. Thirty-three of these 43 countries have a formal statement by a high-ranking official endorsing implementation of the SDGs at the national level; the U.S. does not.

The national budgets of 18 countries address sustainable development; the U.S. budget does not. In 28 countries, a mandated central national institution has identified national indicators to monitor SDG implementation - not in the U.S. Thirty-five countries have comprehensive stakeholder engagement mechanisms to inform the implementation of the SDGs; the U.S. does not. Forty-two of the countries have submitted a Voluntary National Report on SDG implementation to the United Nations or have committed to do so; the U.S. is the only country in the group that has not done so and has not committed to doing so.¹⁷

Climate Action Tracker, run by an international research consortium, assesses government efforts to achieve specific SDGs. They have completed assessments of 30 countries, including all G20 countries. They have found that

¹⁴ *Ibid.* p.10.

¹⁵ *Ibid.* p. 22.

¹⁶ Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G. (2019): Sustainable Development Report 2019. New York, NY: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN). P.xi.

¹⁷ *Ibid.* p.4-9.

strategies and policy actions toward SDG13 “critically insufficient” in five of the 30 countries, including the U.S.¹⁸

SDSN has been tracking an SDG Index for three years, combining what are now 101 indicators of the 17 SDGs. Their 2019 analysis places the U.S. 35th among 162 countries in progress toward achieving the SDGs. This puts the country in a tie with Bulgaria, just behind Costa Rica and Luxemburg, and just ahead of Moldova and Australia. Three Scandinavian countries (Denmark, Sweden, and Finland) top the list; all top 20 countries are OECD members. While the OECD countries top the SDSN Index rankings, they are generally not on track to achieve the SDGs, performing better on socio-economic outcomes and infrastructure while showing major efforts needed on climate mitigation and biodiversity protection (SDGs 12 to 15).¹⁹

The United States has not yet achieved any of the SDGs, showing “Major Challenges” for SDGs 2, 5, 10, 12, 13, 16, and 17, and “Significant Challenges” for SDGs 1, 3, 7, 9, and 11. The best U.S. performance is on SDGs 4, 6, 8, 14, and 15, which are assessed as Challenges Remain. The trend line is better, however. The U.S. is assessed as “On Track” to achieve three SDGs by 2030: 4, 8, and 9; and as “Moderately Increasing” performance on eight SDGs: 1, 2, 3, 5, 6, 7, 11 and 16. The most problematic SDGs for the U.S. are SDGs 10, 13, 14, and 17, which are assessed as “Stagnating.”²⁰

SDSN has also compiled data on SDG achievement for cities in several world regions, including 57 indicators for 105 of the largest MSAs in the USA. None of the most populous cities in the U.S. are on track to achieve the SDGs by 2030. EU cities are generally outperforming U.S. cities with the most striking differences in infant mortality, and the gender wage gap.²¹

The United State’s MSA results, illustrated in Figure 1, demonstrate the largely local nature of SDG achievement. The best performing MSA is San Francisco-Oakland-Hayward CA (index = 69.7 percent); the lowest-performing is Baton Rouge, LA (index = 30.3 percent). The mean index score is 48.9. Nine MSAs score above 60 percent. Population size is not well correlated with the SDG Index,

¹⁸ Climate Action Tracker (2018). “Some Progress since Paris, but Not Enough, as Governments Amble towards 3°C of Warming.” Warming projections global update.

¹⁹ Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G. (2019): Sustainable Development Report 2019: G20 and Large Countries edition. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN). p.20-24.

²⁰ *Ibid.* p. 24-25.

²¹ Lynch, A., LoPresti, A., Fox, C. (2019): The 2019 US Cities Sustainable Development Report. New York, NY: Sustainable Development Solutions Network (SDSN).

although mid-sized MSAs generally performed better than the very large and smaller ones. Attempts to correlate performance with innovation hubs, fast-growth, or post-industrial status resulted in only moderate relationships ($r^2 < .6$). The South Central states had the fewest high performing MSAs with only one MSA in the top twenty. The New England and Pacific region MSAs had the highest performance overall (average ranks of 25 and 36, respectively).²²

Across city-regions in the U.S., the best progress is being made on SDG 6: Clean Water and Sanitation, and 15: Life on Land. In contrast, the least progress is occurring on SDG 2: Zero Hunger, 5: Gender Equality, 7: Affordable and Clean Energy, and 9: Industry, Innovation, and Infrastructure.

Within SDG 11: Sustainable Cities, sustainable transit and rent burden were the worst-performing indicators, while PM2.5 and overcrowded housing were two indicators for which good progress is being made. Sustainable transit looks at the modal split for the bike, rail, walking, and carpooling for the journey to work; only two MSAs are approaching the 2030 target of 50 percent. Less than one-third of commuters get to work sustainably in 103 MSAs. Rent burden looks at the fraction of renters paying more than 30 percent of income on rent; across the sample, at least 40 percent of renters exceeded the target rent percentage.

²² *Ibid.* p. 11-16.

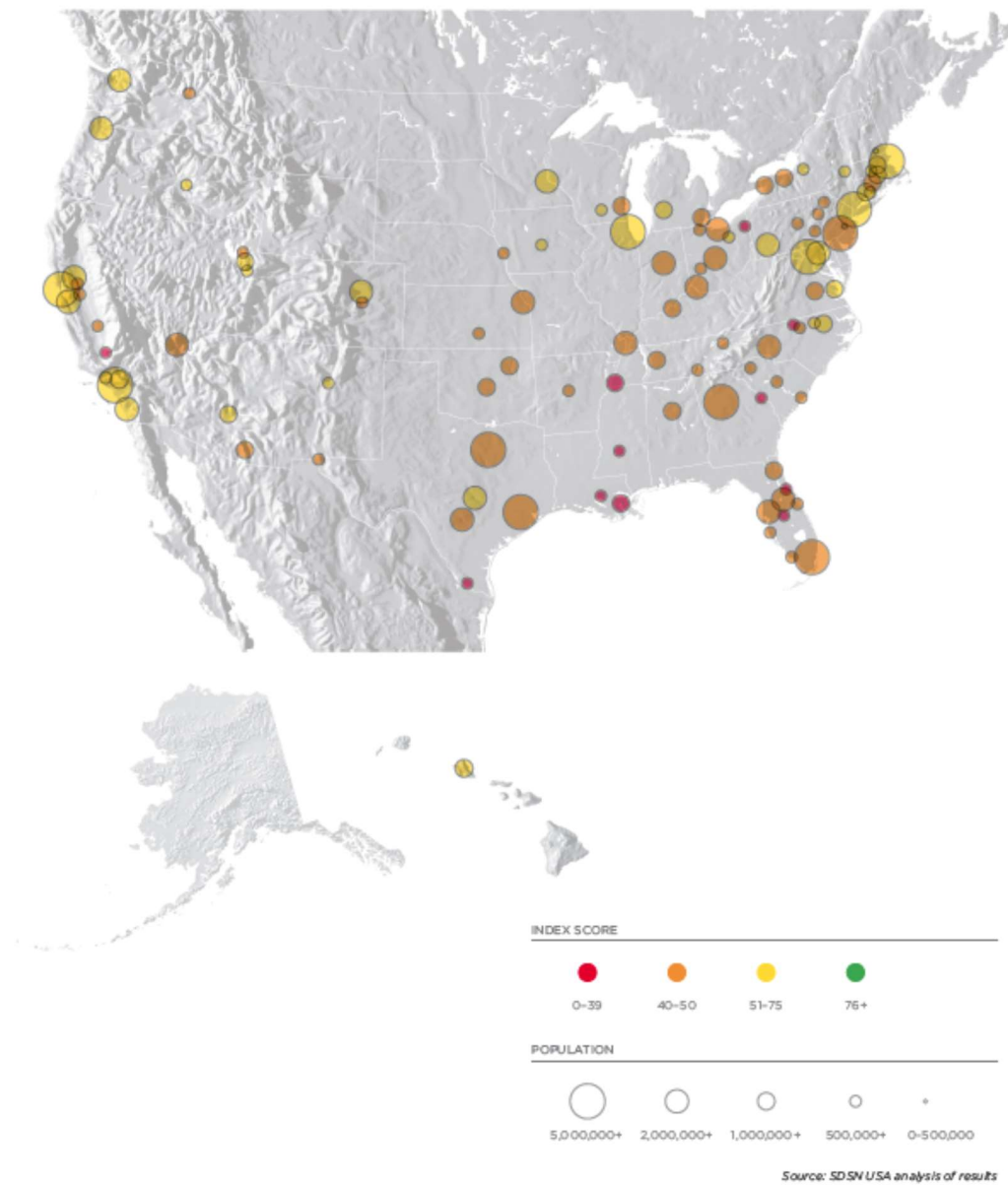


Figure 1. Map of MSAs and Performance (Source: Lynch et al., 2019)

III. TRANSPORT SUSTAINABILITY IN THE 10 LARGEST METROPOLITAN STATISTICAL AREAS IN THE UNITED STATES

Retrospect on transportation sustainability: 2000 and 2017

Trends relative to transportation sustainability in Top 10 MSAs

To examine how the ten largest MSAs (Figure 2) in the U.S. have managed transportation sustainability, we compared a total of seven indicators²³ as suggested in our prior study²⁴ for 2000 and 2017. Note that higher values on some indicators indicate positive contributors. These include population density, per capita Gross Regional Product (GRP), and the ratio of commuters by transit. Similarly, negative contributors include factors such as per capita CO₂ emissions, the ratio of commuters by car, unemployment rate, and poverty rate. Table 3 shows the value of indicators in 2000 and 2017 and the growth rate between the two years.

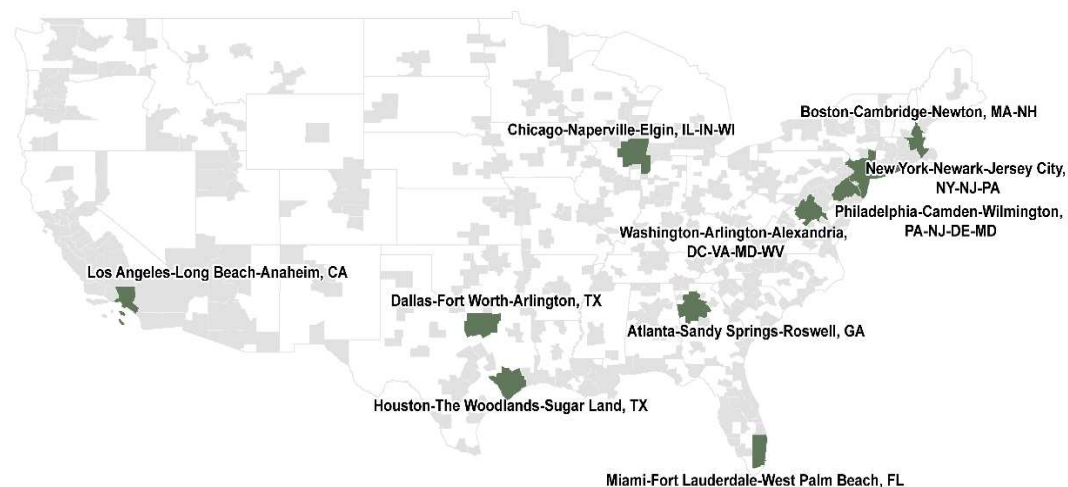


Figure 2. Ten largest MSAs in the U.S.

During the period, population density and per capita GRP increased in all the MSAs, although growth rates varied. Population density grew significantly in MSAs in the southern area, including Houston-The Woodlands-Sugar Land (TX), Dallas-Fort Worth-Arlington (TX), Atlanta-Sandy Springs-Roswell (GA), and Miami-Fort Lauderdale-West Palm Beach (FL). Washington-Arlington-Alexandria (DC-VA-MD-WV) also had significant growth. Per capita, GRP increased mostly

²³ Due to data availability issue, ‘federal expenditure’ indicator is not included.

²⁴ Ross, C., Stiffler, B., Woo, M., & Rao, A. (2010). Measuring Regional Transportation Sustainability: An Exploration. *The Urban Lawyer*, 42/43(4/1), 67-89.

along the east coast with the exception of Los Angeles-Long Beach-Anaheim (CA), which showed the highest increase. While most of the MSAs had growth of per capita GRP higher than 20%, several MSAs had a lower growth rate, including Atlanta-Sandy Springs-Roswell (GA), Dallas-Fort Worth-Arlington (TX), and Chicago-Naperville-Elgin (IL-IN-WI).

Some indicators worsened such as two under the category of Equity. Those worsened with only a few exceptions. The unemployment rate grew in the MSAs except Los Angeles-Long Beach-Anaheim (CA). In some MSAs, the growth was higher than 30%, e.g., Atlanta-Sandy Springs-Roswell (GA), Washington-Arlington-Alexandria (DC-VA-MD-WV), and Boston-Cambridge-Newton (MA-NH). The poverty rate also increased in the MSAs with only two exceptions of Los Angeles-Long Beach-Anaheim (CA) and New York-Newark-Jersey City (NY-NJ-PA). The ratio of commuters by car also increased in most of the MSAs except three MSAs: New York-Newark-Jersey City (NY-NJ-PA), Boston-Cambridge-Newton (MA-NH), and Washington-Arlington-Alexandria (DC-VA-MD-WV).

Other indicators displayed significant variance among MSAs. Per capita, CO₂ emission decreased in most of the MSAs by less than 10%. However, three MSAs that had a growth rate higher than 10%. The ratio of commuters by transit increased in six MSAs, while three MSAs had decreasing rates of more than 10%.

Overall, the MSAs showed improvement in most of the indicators related to environment and economy, while transportation-related indicators showed greater variation among MSAs. Population density and per capita GRP increased in every MSA. With a few exceptions, per capita CO₂ emissions decreased and the ratio of commuters by transit increased. The ratio of commuters by car increased in most MSAs, yet the growth rate was generally less than 5%. In contrast, indicators related to equity worsened in almost every MSA.

Table 3. Comparison of transport sustainability indicators between 2000 and 2017

MSA	Environmental						Economy			Transportation						Equity					
	Population Density ¹⁾			Per capita CO2 emission ²⁾			Per capita GRP ³⁾			Ratio of commuters by car ¹⁾			Ratio of commuters by transit ¹⁾			Unemployment Rate ⁴⁾			Poverty Rate ⁵⁾		
	2000	2017	Growth (%)	2000	2017	Growth (%)	2000	2017	Growth (%)	2000	2017	Growth (%)	2000	2017	Growth (%)	2000	2017	Growth (%)	2000	2017	Growth (%)
Atlanta-Sandy Springs-Roswell, GA	190	253	33.72	5,936	5,447	-8.24	57,640	58,858	2.11	0.77	0.78	0.75	0.04	0.03	-13.48	0.03	0.05	43.36	0.09	0.12	31.95
Boston-Cambridge-Newton, MA-NH	486	528	8.67	3,851	3,630	-5.73	64,348	81,850	27.20	0.71	0.67	-5.46	0.11	0.13	16.31	0.03	0.03	32.76	0.08	0.09	13.16
Chicago-Naperville-Elgin, IL-IN-WI	488	512	4.96	3,831	4,257	11.11	53,433	62,866	17.65	0.70	0.71	0.15	0.12	0.12	3.73	0.04	0.05	11.47	0.10	0.12	13.26
Dallas-Fort Worth-Arlington, TX	217	296	36.52	5,681	6,688	17.72	57,580	65,727	14.15	0.79	0.81	2.52	0.02	0.01	-19.29	0.04	0.04	5.20	0.11	0.12	9.11
Houston-The Woodlands-Sugar Land, TX	219	310	41.40	5,236	6,177	17.97	51,804	66,767	28.88	0.77	0.80	4.37	0.03	0.02	-32.92	0.04	0.05	18.31	0.13	0.14	5.61
Los Angeles-Long Beach-Anaheim, CA	984	1,056	7.25	4,262	4,163	-2.32	50,053	71,271	42.39	0.72	0.75	4.12	0.06	0.05	-6.02	0.05	0.04	-9.62	0.16	0.14	-12.03
Miami-Fort Lauderdale-West Palm Beach, FL	382	459	20.21	4,314	4,208	-2.44	42,382	51,459	21.42	0.77	0.78	1.21	0.03	0.04	9.94	0.04	0.04	5.95	0.14	0.15	5.28
New York-Newark-Jersey City, NY-NJ-PA	882	940	6.59	3,094	3,189	3.08	59,478	75,598	27.10	0.54	0.50	-6.63	0.27	0.31	13.63	0.04	0.04	1.82	0.13	0.13	-4.26
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	477	509	6.66	4,392	4,228	-3.75	51,415	65,994	28.35	0.73	0.73	0.07	0.09	0.10	5.44	0.04	0.05	21.54	0.11	0.12	18.21
Washington-Arlington-Alexandria, DC-VA-MD-WV	299	376	25.90	4,850	4,084	-15.80	61,392	75,998	23.79	0.68	0.66	-2.23	0.11	0.14	21.35	0.03	0.04	37.41	0.07	0.08	10.15

1. "Decennial US Census (2000)" & "American Community Survey (2017)", U.S. Census Bureau. Accessed January 13, 2020.

2. EARTHDATA, DARTE (v2) Annual On-road CO2 Emissions on a 1-km Grid 1980-2017, https://daac.ornl.gov/daacdata/cms/CMS_DARTE_V2/data/

3. Woods & Poole Economics, Inc (2018), Regional Projections and Database

4. U.S. Bureau of Labor Statistics, Local Area Unemployment Statistics, <https://www.bls.gov/lau/#tables>

5. U.S. Census Bureau, Small Area Income and Poverty Estimates, <https://www.census.gov/data/datasets/2018/demo/saipe/2018-state-and-county.html>

Top 10 MSAs and their relative performance

MSAs were also examined to determine which were most successful regarding transport sustainability. For comparison, each indicator was standardized using z-scores and summarized to create a ranking (Table 4).

Most of the MSAs maintained the same rankings in 2000 and 2017. New York-Newark-Jersey City (NY-NJ-PA), Boston-Cambridge-Newton (MA-NH), and Washington-Arlington-Alexandria (DC-VA-MD-WV) remained in the top three. At the same time, Houston-The Woodlands-Sugar Land (TX) had the lowest rank. Only two MSAs had relatively noticeable changes in ranking. Los Angeles-Long Beach-Anaheim (CA) rose from 6th to 4th, as it had significant growth in per capita CO₂ emission and per-capita GRP. However, Atlanta-Sandy Springs-Roswell (GA) fell from 7th to 9th and its per capita GRP, unemployment rate, and the poverty rate have not improved in comparison to the other MSAs.

In 2000 for New York-Newark-Jersey City (NY-NJ-PA) and Boston-Cambridge-Newton (MA-NH), most indicators were higher than average. In particular, New York-Newark-Jersey City (NY-NJ-PA) had better indicators in the environmental and transportation categories. At the same time, the Boston-Cambridge-Newton (MA-NH) MSA was better in both the economy and equity categories. The Washington-Arlington-Alexandria (DC-VA-MD-WV) ranked better than the average in every category except environmental. The Dallas-Fort Worth-Arlington (TX) and Atlanta-Sandy Springs-Roswell (GA) indicators were worse than the average.

In 2017, the Boston-Cambridge-Newton (MA-NH) and Washington-Arlington-Alexandria (DC-VA-MD-WV) had better than average indicators. Both of the MSAs had particular improvement in per capita CO₂ emission, the ratio of commuters by transit, and the poverty rate. The New York-Newark-Jersey City (NY-NJ-PA) MSA still ranked lower than average on the equity category, although overall, it had the highest score. The Atlanta-Sandy Springs-Roswell (GA), Philadelphia-Camden-Wilmington, (PA-NJ-DE-MD), and Houston-The Woodlands-Sugar Land (TX) all had indicators that were either worse or no better in 2017 than in 2000. The Atlanta-Sandy Springs-Roswell (GA) and Philadelphia-Camden-Wilmington, (PA-NJ-DE-MD) MSA both made progress in reducing per capita CO₂ emission and share of car commuters, whereas not making much progress in increasing population density. The Houston-The Woodlands-Sugar Land (TX) worsened in per capita CO₂ emission, the ratio of car commuters, unemployment rate, and poverty rate.

The general trend shows that per capita GRP and rankings of total z-score have a positive relationship. The Atlanta-Sandy Springs-Roswell (GA) and Chicago-Naperville-Elgin (IL-IN-WI) had lower ranks overall and lower performance in per capita GRP. The opposite case is evident as Los Angeles-Long Beach-Anaheim (CA) MSA, which had an improvement of two ranks and Miami-Fort Lauderdale-West Palm Beach (FL) MSA that improved by one rank.

Table 4. Comparison of transport sustainability indicators between 2000 and 2017 (Z-score)

MSA	Environmental				Economy		Transportation				Equity				Total Z- score		Rank by total Z-score	
	Population density ¹⁾		Per Capita CO2 emission ²⁾		Per capita GRP ³⁾		Ratio of Commuter s by Car ⁴⁾		Ratio of Commuter s by Transit ⁵⁾		Unemplo yment rate ⁶⁾		Poverty rate ⁷⁾					
	2000	2017	2000	2017	2000	2017	2000	2017	2000	2017	2000	2017	2000	2017	2000	2017	2000	2017
Atlanta-Sandy Springs-Roswell, GA	-0.99	-1.00	-1.28	-0.88	0.42	-0.98	-0.63	-0.57	-0.70	-0.72	0.65	-0.42	0.55	-0.26	-1.99	-4.84	7	9
Boston-Cambridge-Newton, MA-NH	0.09	0.02	0.68	0.95	1.46	1.59	-0.02	0.31	0.34	0.41	1.85	1.94	1.15	1.19	5.55	6.42	2	2
Chicago-Naperville-Elgin, IL-IN-WI	0.09	-0.04	0.71	0.14	-0.24	-0.53	0.06	0.00	0.36	0.27	-0.70	-0.87	0.15	0.02	0.44	-1.01	4	5
Dallas-Fort Worth-Arlington, TX	-0.90	-0.85	-1.12	-1.56	0.41	-0.21	-0.80	-0.79	-0.93	-0.90	0.12	1.08	0.03	0.06	-3.19	-3.17	8	7
Houston-The Woodlands-Sugar Land, TX	-0.89	-0.79	-0.80	-1.31	-0.49	-0.10	-0.64	-0.77	-0.74	-0.82	-0.63	-1.13	-0.82	-0.85	-5.01	-5.78	10	10
Los Angeles-Long Beach-Anaheim, CA	1.90	1.97	0.14	0.25	-0.76	0.41	-0.11	-0.36	-0.42	-0.48	-1.16	-0.36	-1.31	-0.79	-1.71	0.64	6	4
Miami-Fort Lauderdale-West Palm Beach, FL	-0.29	-0.24	0.08	0.20	-1.96	-1.81	-0.66	-0.61	-0.73	-0.66	-0.46	-0.07	-0.91	-0.95	-4.92	-4.14	9	8
New York-Newark-Jersey City, NY-NJ-PA	1.53	1.54	2.06	1.71	0.70	0.89	2.62	2.57	2.46	2.42	-0.78	-0.41	-0.77	-0.37	7.82	8.36	1	1
Philadelphia-Camden-Washington, PA-NJ-DE-MD	0.05	-0.06	-0.01	0.17	-0.55	-0.18	-0.23	-0.22	0.03	0.00	-0.30	-0.75	0.05	-0.30	-0.97	-1.34	5	6
Washington-Arlington-Alexandria, DC-VA-MD-WV	-0.60	-0.55	-0.47	0.34	1.00	0.94	0.41	0.43	0.33	0.47	1.41	0.98	1.88	2.24	3.97	4.86	3	3

1. "Decennial US Census (2000)" & "American Community Survey (2017)", U.S. Census Bureau. Accessed January 13, 2020.

2. EARTHDATA, DARTE (v2) Annual On-road CO2 Emissions on a 1-km Grid 1980-2017, https://daac.ornl.gov/daacdata/cms/CMS_DARTE_V2/data/

3. Woods & Poole Economics, Inc (2018), Regional Projections and Database

4. U.S. Bureau of Labor Statistics, Local Area Unemployment Statistics, <https://www.bls.gov/lau/#tables>

5. U.S. Census Bureau, Small Area Income and Poverty Estimates, <https://www.census.gov/data/datasets/2018/demo/saipe/2018-state-and-county.html>

Transport sustainability indicators in the new era

Selection of indicators

Table 5 shows the selected 14 transportation sustainability indicators in four categories. The first category is “Land use and spatial structure,” which includes population density, the spatial match between working and living, average travel time to work, and the ratio of commuters by transit. High population density has a positive relationship with the effective operation of public transport (Currie & De Gruyter, 2018). The spatial match between residence and employment is measured by the proportion of workers who work and live in the same MSA. This has been identified as a critical issue in transport and planning policies in several respects (Ma & Banister, 2006). Mismatch of residence and employment has been cited as a primary cause of expanded commuting, contributing to negative impacts on the environment through traffic congestion and emission (Scott et al., 1997). Long travel times resulting from long commutes can also negatively impact subjective wellbeing (Clark et al., 2019). From many perspectives, spatial match of residence and employment is related to social and environmental sustainability. The ratio of transit commuters and the ratio of commuters who drive alone are indicators that are relevant to land use and spatial structure.

The second category is “Inclusiveness and safety.” This category directly corresponds with SDG 11, “Make cities and human settlements inclusive, safe, resilient and sustainable.” Among the ten targets of SDG 11, we selected two targets that are related to transport sustainability. Target 2 aims to provide accessible and sustainable transport systems for all, mainly by expanding public transport. In the SDGs, “the proportion of the population that has convenient access to public transport, by sex, age and persons with disabilities” is suggested. We focused on ADA accessibility by utilizing two indicators: ADA vehicle availability in public transit service; and ADA accessible station availability in public transit service. In addition to Target 2, we selected Target 6, which is “By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality...” As a corresponding indicator of Target 6, we applied “annual mean levels of fine particulate matter in cities,” which was suggested by the SDGs as an indicator for Target 6.

The third category is “Innovation adaptability,” which is linked to SDGs 7, 9, and 12. Goal 7 is “Ensure access to affordable, reliable, and modern energy for all.” We applied alternative fuel station availability as a corresponding indicator of Target 1 of SDG 7, which is “By 2030, ensure universal access to affordable, reliable and modern energy services.” Another indicator we selected for SDG 7 is CO₂ emission. It is linked to Target 2 of SDG 7, which states, “By 2030, increase

substantially the share of renewable energy in the global energy mix.” For SDG 9, “Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation,” per capita CO₂ emission was selected, and is linked to Target 4, “By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies ...” The last indicator in this category is the ratio of non-motorized commutes that includes commuting by walking and biking or working at home. This indicator corresponds with Target 8 of SDG 8, which is “By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.” In OECD’s Transport Outlook (2019), walking and cycling are active transport modes that can significantly decrease CO₂ emissions in its ‘high ambition scenario’ (OECD, 2019). The report also references the contribution of teleworking on decreasing urban passenger trips and CO₂ emissions.

The last category is “Economic sustainability.” The economic sustainability of transport is not explicitly addressed in the SDGs. However, economic sustainability is one of the three pillars of sustainable development. Also, transport is a system that needs a vast amount of resources. Therefore, economic considerations are important considerations in achieving increased resilience and sustainability. Consequently, we included three indicators in the economic category. The first indicator is the local government’s financial commitment to public transit. It is measured by the proportion of expenditures on transit out of the expenditure on both transit and any type of roadways except for tolled highways. The second indicator is the net revenue of highway and road, and the third indicator is the net revenue of public transit. For both indicators, the revenue consists of subsidy from state or federal government and current charges, while the expenditures consist of the current operation, construction, and land and existing structures.²⁵

²⁵ The data is gathered from 2017 Annual Survey of State and Local Government Finances. The classification of revenue and expenditure is based on Government Finance and Employment Classification Manual (2006).

Table 5. Selected indicators of transport sustainability

Category	Indicator	Description	Source
Land use & spatial structure (UNSDG Goal 9, 11)	Population density	Total population/Km ²	ACS
	Spatial match	Work & live in the same area/Total workers live in the MSA	ACS
	Ratio of commuters by transit	N. of transit users/ Total N. of commuters	ACS
	Ratio of commuters by car (alone)	N. of commuters who drive alone/Total N. of commuters	ACS
Inclusiveness and safety (UNSDG Goal 11)	PM 2.5 level	Weighted annual mean (µg/m ³)	EPA
	ADA vehicle availability in transit service	N. of ADA acc. Vehicles/Total active vehicles	NTD
	ADA accessible station availability in transit service	N. of ADA accessible stations/Total stations	NTD
Adaptation to innovation (UNSDG Goal 7, 9, 12)	Total CO2 emission from public transit	CO2 emission * Fuel used by types/VOMS	EPA, NTD
	Ratio of non-motorized commute	N. of workers who work at home or commute by walking or biking/Total N. of commuters	ACS
	Alternative fuel stations availability	Car commuters/Total N. of AF station	NREL
	Per capita CO2 (roadside only)	Kg/person	EARTH
Economic sustainability	Financial commitment to public transit	Expenditure on transit/ (Expenditure on transit + Expenditure on road)	ACS
	Revenue – Expenditure (Highway & road)	Revenue (subsidy + current charge) – Expenditure (current operation + construction + land and existing structures)	ACS
	Revenue – Expenditure (Public transit)	Revenue (subsidy + current charge) – Expenditure (current operation + construction + land and existing structures)	ACS

Sustainability performance in the ten MSAs: new indicators

The 10 MSAs' transport sustainability indicators are measured and compared by z-score in (Table 6). The scores for each indicator is calculated for each MSA and they are ranked. Also, to justify our selection of indicators, we referenced the index from the 2019 U.S. Cities Sustainable Development Report (SDR index)²⁶ and the rankings of cities based on the SDR index and compared the rankings with our ranking. The ranking by the SDR index is made for the 10 MSAs.²⁷

In the Land Use and Spatial Structure category, New York-Newark-Jersey City (NY-NJ-PA) has higher scores than most of the other MSAs. It has the highest scores for the ratio of commuters by transit and also by car, and the second-highest scores for population density and spatial match. Los Angeles-Long Beach-Anaheim (CA) has the highest score for population density and higher than the average score for the spatial match. Generally, the MSAs having lower rankings by the SDR index have relatively higher scores for spatial match.

In the Inclusiveness and Safety category, Boston-Cambridge-Newton (MA-NH) and Washington-Arlington-Alexandria (DC-VA-MD-WV) have higher scores across indicators. In particular, the Boston-Cambridge-Newton (MA-NH) MSA has the best air quality with more ADA accessible vehicles in its public transit fleet, while the Washington-Arlington-Alexandria (DC-VA-MD-WV) MSA all three indicators are better than average. Philadelphia-Camden-Wilmington (PA-NJ-DE-MD) MSA's air quality and the ratio of ADA accessible stations are the lowest among the ten MSAs.

The Adaptation to Innovation category shows great variance among regions. Generally, MSAs in the northern region have higher scores including the New York-Newark-Jersey City (NY-NJ-PA), Philadelphia-Camden-Wilmington (PA-NJ-DE-MD), and the Washington-Arlington-Alexandria (DC-VA-MD-WV) MSA. These three MSAs score higher than average in the ratio of non-motorized commutes, CO₂ emission from public transit and per capita roadside emissions. The MSAs in the southern region tend to have lower scores, including Atlanta-Sandy Springs-Roswell (GA), Houston-The Woodlands-Sugar Land (TX), Dallas-Fort Worth-Arlington (TX), and the Miami-Fort Lauderdale-West Palm Beach (FL) MSA. Except for the Miami-Fort Lauderdale-West Palm Beach (FL) MSA the

²⁶ Lynch, A., LoPresti, A., Fox, C. (2019): The 2019 US Cities Sustainable Development Report. New York, NY: Sustainable Development Solutions Network (SDSN).

²⁷ In the 2019 US Cities Sustainable Development Report, total 105 cities are indexed and ranked.

other three MSAs have lower scores for per capita CO₂ emission, the ratio of non-motorized commutes, and availability of alternative fuel stations.

In the Economic Sustainability category, most of the MSAs have divergent scores. For instance, Boston-Cambridge-Newton (MA-NH) and the Atlanta-Sandy Springs-Roswell (GA) MSAs have lower scores for public transit commitment, but their two revenue-expenditure indicators are better than average. The Houston-The Woodlands-Sugar Land (TX) and Dallas-Fort Worth-Arlington (TX) MSAs scored higher than the average for revenue-expenditure on roads. While the Miami-Fort Lauderdale-West Palm Beach (FL), and the Los Angeles-Long Beach-Anaheim (CA), and Washington-Arlington-Alexandria (DC-VA-MD-WV) MSAs have greater public transit commitment and revenue-expenditure from roads.

Even with the new set of indicators, the relative sustainability performance of the MSAs is consistent in 2000 and 2017. The rankings of the MSAs also generate performance generally identical to the 2000s and 2017s. The top three MSAs are New York-Newark-Jersey City (NY-NJ-PA), Washington-Arlington-Alexandria (DC-VA-MD-WV) and Boston-Cambridge-Newton (MA-NH). These MSAs are also the top three based on the SDR index. The Houston-The Woodlands-Sugar Land (TX), Miami-Fort Lauderdale-West Palm Beach (FL), and the Atlanta-Sandy Springs-Roswell (GA) MSAs have remained in the lower ranks in both 2000 and 2017 employing the old indicators, and the new indicators in 2017.

Table 6. Transport sustainability indicators and ranking

MSA	Land use & Spatial structure				Inclusiveness & safety			Adaptation to innovation				Economic sustainability			Total	Rank	
	Population density ¹⁾	Spatial match ¹⁾	Ratio of commuters ¹⁾		PM 2.5 level ²⁾	ADA accessibility of public transit ³⁾		CO2 emission		Ratio of non-motorized commuters ¹⁾	Availability of alternative fuel stations ⁵⁾	Public transit commitment ⁶⁾	Revenue - Expenditure ⁶⁾		Z-score	Z-score	SDR index ⁷⁾
			By transit	By car		Ratio of vehicle	Ratio of station	Public transit ³⁾	Per capita ⁴⁾				Road	Public transit			
Atlanta-Sandy Springs-Roswell, GA	-1.00	-0.16	-0.72	-0.57	-0.53	-0.81	0.72	0.86	-0.88	-0.28	-0.02	-0.76	0.29	0.20	-3.68	8	7
Boston-Cambridge-Newton, MA-NH	0.02	-1.37	0.41	0.31	2.17	1.08	-0.17	-1.22	0.95	1.55	-0.27	-2.09	0.67	0.08	2.12	3	2
Chicago-Naperville-Elgin, IL-IN-WI	-0.04	0.8	0.27	0	0.12	0.16	-0.32	-0.67	0.14	-0.02	0.77	0.28	-0.76	0.03	0.78	4	5
Dallas-Fort Worth-Arlington, TX	-0.85	0.75	-0.9	-0.79	-0.53	0.18	0.72	0.46	-1.56	-1.11	-1.04	-0.73	0.10	-0.23	-5.53	9	9
Houston-The Woodlands-Sugar Land, TX	-0.79	0.81	-0.82	-0.77	-0.96	-0.99	0.72	0.35	-1.31	-1.7	-0.88	-0.51	0.72	-0.19	-6.32	10	10
Los Angeles-Long Beach-Anaheim, CA	1.97	0.07	-0.48	-0.36	-1.42	-1.76	0.72	-0.72	0.25	0.12	1.73	0.8	-0.70	-1.72	-1.50	6	4
Miami-Fort Lauderdale-West Palm Beach, FL	-0.24	0.98	-0.66	-0.61	0.65	0.14	0.35	-1.61	0.20	-0.6	-0.55	0.32	1.03	-0.14	-0.74	5	8
New York-Newark-Jersey City, NY-NJ-PA	1.54	0.64	2.42	2.57	0.47	1.6	-1.6	0.27	1.71	1.3	0.64	0.98	-2.30	2.31	12.56	1	3
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	-0.06	-1.84	0	-0.22	-0.26	-0.23	-1.88	0.78	0.17	0.2	-1.35	0.73	0.66	0.32	-2.98	7	6
Washington-Arlington-Alexandria, DC-VA-MD-WV	-0.55	-0.68	0.47	0.43	0.29	0.63	0.72	1.49	0.34	0.55	0.98	0.98	0.29	-0.66	5.28	2	1

1. U.S. Census Bureau, American Community Survey (2017)

2. EPA, Air Quality Trends by City 2000 – 2018, <https://www.epa.gov/air-trends/air-quality-cities-and-counties>

3. Federal Transportation Administration, National Transit Database (2017); EPA, Emission Factors for Greenhouse Gas Inventories (2018)

4. EARTHDATA, Annual On-road CO2 Emissions on a 1-km Grid 1980-2017, https://daac.ornl.gov/daacdata/cms/CMS_DARTE_V2/data/; U.S. Census Bureau, American Community Survey (2017)5. National Renewable Energy Lab, AFDC TransAtlas, <https://maps.nrel.gov/transatlas/>

6. U.S. Census Bureau, Annual Survey of State and Local Government Finances (2017)

7. Sustainable Development Solutions Network, The 2019 US Cities Sustainable Development Report (2019)

IV. CONCLUSIONS AND POLICY RECOMMENDATIONS

The United States was instrumental in the U.N. adoption of the SDGs in 2015, but within two years, a change of national administration led to the reversal of position concerning the goals. Since then, the U.S. government has been reluctant to set policy based on the SDGs, has reversed many programs that were SDG oriented, and has refused to engage with the global SDG data monitoring system. Despite this national position, many states, cities, and firms in the U.S. have continued to advance objectives, policies, and programs that are SDG oriented. Today, U.S. cities have made considerable progress toward many of the goals, most notably SDG 6: Clean Water and Sanitation, and SDG 15: Life on Land. Other goals, including SDG 2: Zero Hunger, SDG 5: Gender Equality, SDG 7: Affordable and Clean Energy, and SDG 9: Industry, Innovation, and Infrastructure, are not on track for completion in 2030. In particular, only two U.S. MSAs are on track to meet the transportation sustainability targets in SDG 11: Sustainable Cities.

In 28 of the world's largest and/or most developed countries, a mandated central national institution has identified national indicators to monitor SDG implementation - not in the U.S.. Thirty-five countries have comprehensive stakeholder engagement mechanisms to inform the implementation of the SDGs; the U.S. does not. Forty-two of the countries have submitted a Voluntary National Report on SDG implementation to the United Nations or have committed to do so; the U.S. is the only country in the group that has not done so and has not committed to doing so.²⁸ SDSN has been tracking an SDG Index for three years combining what are now 101 indicators of the 17 SDGs. Their 2019 analysis places the U.S. 35th among 162 countries in progress toward achieving the SDGs.

Cities and regions are providing the leading edge of the movement toward sustainable transportation in the United States and it is contemplated that they will continue to provide this leadership. Our results clearly demonstrate the largely local nature of SDG achievement. To examine how the ten largest MSAs in the U.S. have managed transportation sustainability, we compared a total of seven indicators²⁹ that was suggested in our prior study³⁰ for 2000 and 2017. Overall, the MSAs showed improvement in most of the indicators related to environment and economy, while transportation-related indicators showed significant variation among the MSAs. Population density and per capita GRP increased in every MSA.

²⁸ Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G. (2019): Sustainable Development Report 2019: G20 and Large Countries edition. New York: Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN). p.4-9.

²⁹ Due to data availability issue, 'federal expenditure' indicator is not included.

³⁰ Ross, C., Stiffl, B., Woo, M., & Rao, A. (2010). Measuring Regional Transportation Sustainability: An Exploration. *The Urban Lawyer*, 42/43(4/1), 67-89.

Still, the current situation varies widely, with the best performing USA MSA, San Francisco-Oakland-Hayward CA, about two-thirds of the way toward SDG achievement and the lowest-performing, Baton Rouge, LA., less than one-third of the way.

If United States' cities are to come close to achieving the Sustainable Development Goals by 2030, we must develop an innovative national policy requiring sustainability as a primary requirement in the traditional transportation planning in regions with a population of 50,000 or more. Metropolitan Planning Organizations (MPOs) oversee the traditional transportation planning process in cities and regions and must adhere to many federal requirements, including the Clean Air Act Amendments, financial constraints, the National Environmental Policy Act (NEPA) of 1969, and other statutory requirements. In particular, the regional Transportation Improvement Program and the Regional Transportation Plan requirements are linked to the allocation of federal dollars and could be powerful tools to advance sustainability. A national sustainability policy would then become part of the primary requirements under which MPOs conduct transportation planning activities. Requiring the documentation and inclusion of sustainability performance indicators in the transportation planning process in cities over 50,000 would guarantee the inclusion of these metrics in MPO planning. The inclusion of sustainability metrics in the national and regional planning processes increases the probability and the potential of transportation investment to enable sustainable cities, towns, and regions.

Further, inclusion of a sustainability policy would propel the U.S. toward greater compliance with the SDGs. This would help in promoting a transport system that will achieve greater energy efficiency, improve safety, enhance mobility diversity, improve health outcomes, and increase pedestrian activity, biking, and walking. Given the lack of a sustainable national policy, cities and regions have taken it upon themselves to begin to implement sustainable transport systems and practices with limited leadership from the federal government.

It is increasingly clear that a part of the policy envelope must include metrics that attempt to both frame and track improvements in transport sustainability for both the short and long term. Such a shift in U.S. policy would align it with other countries throughout the world. More importantly, it would enable policy evaluations that could lead to reducing the effects of climate change, reliance on fossil fuels, and improvement in the quality of life in our cities and regions. Transport drives and supports development, mobility, and economic success in our cities and regions. The connectivity of the transport system to many other social, economic and environmental factors, requires transport to be measured

by the inclusion of targets and metrics that capture this interconnectivity and the resulting societal contributions and impacts.

The importance of sustainable transport is evident in the transition from the MDGs of 2000 to the SDGs of 2015. SDGs 3, 9, and 11 include ensuring healthy lives, rebuilding resilient infrastructure, promoting inclusive and sustainable industrialization, and making cities safe, resilient, and sustainable. These goals are more achievable if they are undergirded by sustainable transport.

Undeniably, many of the SDG goals are overlapping. We have focused on metrics to measure the United States progress being led by our cities and regions focusing on these accomplishments relative to goals 3, 9, and 11 of the SDGs. These goals embrace a broad definition of sustainable transport and its many linkages. FHWA's INVEST model is one attempt to develop a transportation self-assessment sustainability rating system. The INVEST experience underscores one of the major challenges confronting the United States, and our cities and regions: the lack of a coherent, comprehensive sustainable transportation policy.

Time for policy action on the SDGs is short. Neither the national nor municipal/regional governments can wait to act. At the same time, we have to learn more about the relationships between the various possible policy actions and SDG achievement. Considerable analysis is necessary, an analysis that can only be possible with better data and careful research design. Needed research includes quality program evaluation tied to consistent metrics and both comparative and longitudinal research that contrasts the consequences of different approaches in U.S. cities and regions with those in use in other countries.

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